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# INSTRUMENTATION AND CONTROLS OVERVIEW

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SUMMARY

The Lewis Research Center has had a long history of research directed toward advancing the Nation's capability in the areas of propulsion research instrumentation and propulsion controls. This session will highlight some of the major advances from this research as well as highlight some of the planned research that will strongly impact our future capabilities. The presentations will cover our efforts on research instrumentation and controls as well as our efforts in high-temperature electronics.

This introductory section will focus on the goals, scope and major thrusts in each of the research areas.

# Instumentation and Controls Research

- **Propulsion instrumentation**
- **High temperature electronics**
- **Controls**

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The Lewis Research Center's Instrumentation and Controls Research Program consists of three main elements: propulsion instrumentation research, high-temperature electronics research, and controls research.

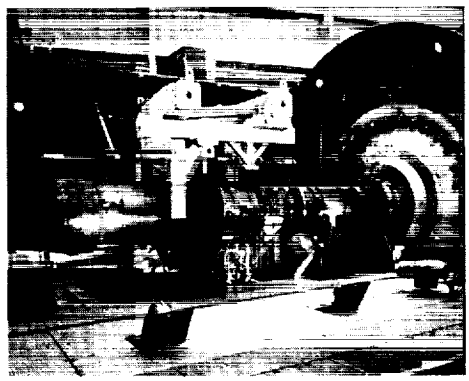
# Propulsion Instrumentation Research

**Goal: Provide the instrumentation technology advances needed to support future aeropropulsion research and development**

**Scope of applications:**

**Fundamental studies**

**Component R&D**



**Propulsion system R&D**

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The goal of the Propulsion Instrumentation Research Program is to provide the instrumentation technology advances needed to support future aeropropulsion research and development. Instrumentation is being developed for a wide range of applications which include fundamental studies of basic phenomena, propulsion system component research and development, and propulsion system research and development. Examples shown include fundamental studies of combustion phenomena in a flat-flame burner, detailed measurements of flow in a turbine stator cascade, and propulsion system tests using an advanced engine in a altitude simulation chamber.

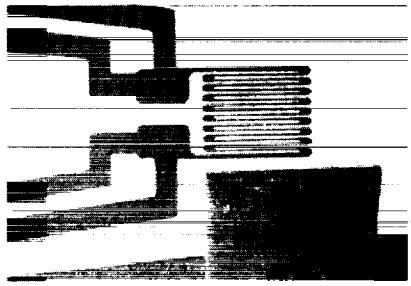
# Propulsion Instrumentation Research

**Thrusts:**

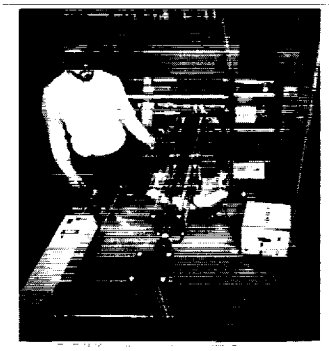
**Develop measurements capabilities**

- **For use in hostile propulsion system environments**
- **For use in conjunction with advanced materials (e.g., ceramics, composites)**
- **That provide information over 2-D or 3-D regions**
- **That provide multiparameter measurements**

**Research focus:**



**Contact sensors**



**Remote optical measurement systems**

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The Propulsion Instrumentation Research Program includes many thrusts. Some of the major thrusts include the development of measurement capabilities for use in hostile propulsion system environments and for use in conjunction with advanced propulsion system materials such as ceramics and composites. Other thrusts focus on the development of measurement systems that provide information over a two-dimensional or three-dimensional space and on measurement systems that provide multiparameter measurements. The "bottom line" thrust is to develop the measurement capabilities that will provide the quality data needed to accurately assess performance and to validate a wide variety of aero-thermal-structural codes.

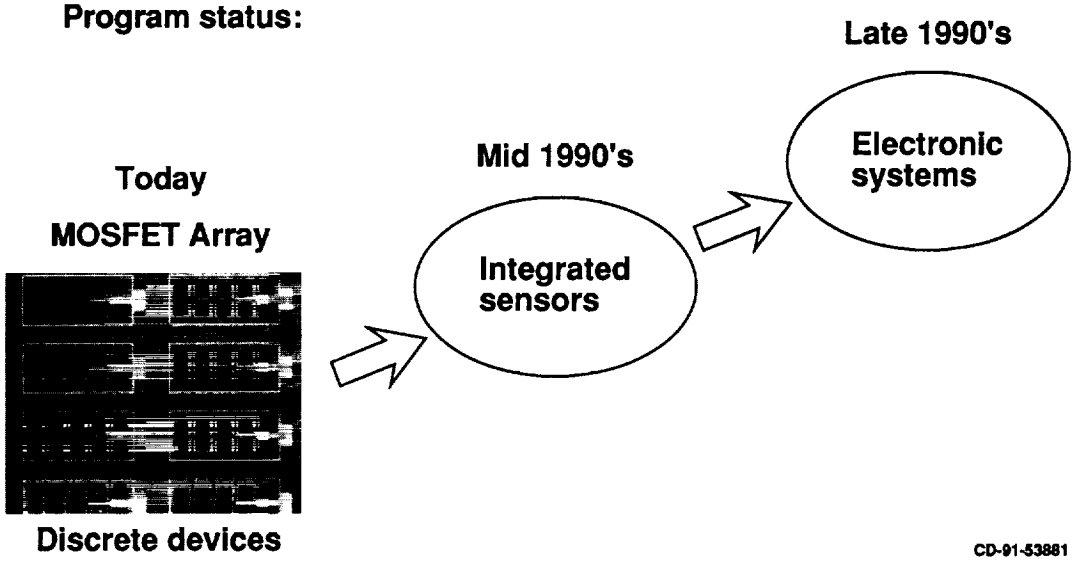
The research focus includes two main types of instrumentation: Contact sensors and remote optical measurement systems. The Lewis program gives equal emphasis to the two types of instrumentation. Examples shown include a thin-film strain gage on a ceramic substrate and an optical system for making remote measurements of strain on a test specimen. Both instruments are designed for making static strain measurements at high-temperature.

# High Temperature Electronics Research

**Goal: Provide the solid state semiconductor technology needed for a wide variety of high temperature integrated sensors and other electronic devices**

**Research focus: Silicon carbide based technology**

**Program status:**




The goal of the High Temperature Electronics Research Program is to provide the solid state semiconductor technology needed for a wide variety of high-temperature integrated sensors and other electronic devices. The research focus is on silicon carbide since it has a potential maximum operating temperature capability far higher than the 300 °C capability of silicon.

The program has made significant progress in the past few years. Today, we have demonstrated in the laboratory discrete semiconductor devices such as a Metal-Oxide-Semiconductor-Field-Effect-Transistor (MOSFET) operating at temperatures of 500 °C. Our goal by the mid 1990's is to demonstrate integrated electronic sensors, and by the late 1990's we hope to demonstrate high-temperature electronic systems.

# High Temperature Electronics Research

**Thrusts: Silicon carbide semiconductor crystal growth and characterization**

**Electronic device fabrication (e.g., diodes, transistors)**

Crystal growth | Characterization | Device fabrication

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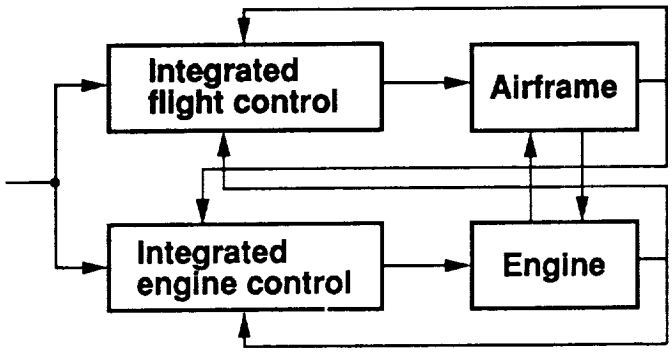
The High Temperature Electronics Research Program currently has two major thrusts: Silicon carbide semiconductor crystal growth and characterization and electronic device fabrication. Strong emphasis is placed on the crystal growth and characterization efforts since the production of electronic devices is critically dependent on the availability of large-size and defect-free crystals. Shown are a chemical vapor deposition system for growing the crystals, an energy dispersive x-ray analyzer system for characterizing the crystals, and an optical mask aligner employed in the device fabrication process.

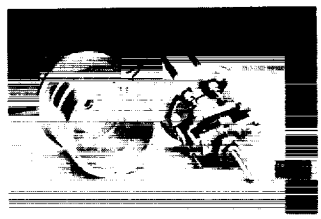
# Controls Research

**Goal: Provide the advanced control technologies (i.e., control hardware and design methodologies) needed to support a wide variety of future aircraft and propulsion systems**

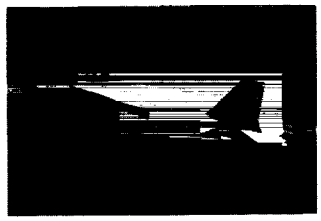
**Research scope:**




**Advanced control design**



**Control sensor R&D**



**Flight validation**

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The goal of the Controls Research Program is to provide the advanced control technologies needed to support a wide variety of future aircraft and propulsion systems. Primary emphasis is on propulsion controls. The program scope includes control sensor research and development, design of advanced control systems, and flight validation of advanced controls. Shown are a block diagram of an integrated propulsion/airframe control system, an optical angular position encoder for use in a fly-by-light control system, and the F-18 aircraft on which we plan to conduct flight testing of a fly-by-light propulsion/airframe control system.

# Controls Research

**Thrusts:**

- **Fly-by-light controls technology**
- **NASP propulsion system dynamics and controls**
- **ASTOVL integrated controls**
- **Life extending controls**

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Our Controls Research Program contains numerous thrusts. Listed are those which we will highlight in this conference. As the list indicates, our efforts cover a very broad spectrum.